

1 THE EMBODIMENTS OF THE INVENTION FOR WHICH AN
2 EXCLUSIVE PROPERTY OR PRIVILEGE IS CLAIMED ARE DEFINED AS
3 FOLLOWS:

5 1. A system for enhancing gas recovery from a tubing string
6 extending down a wellbore into a reservoir having diminished pressure, the tubing
7 string accumulating liquid from fluids produced from the reservoir, the system
8 comprising:

9 - a packer sealingly engaged in the wellbore for forming an
10 annulus between an exterior of the tubing string and an interior of a casing string
11 above the packer, the annulus being isolated from the reservoir;

12 - a source of high pressure gas connected to the annulus so as
13 to allow pressure to continuously build within the annulus;

14 - a valve located in a bore of the tubing string adjacent the
15 packer; and

16 - means for actuating the valve from a production position,
17 wherein one or more production ports are opened, fluidly connecting the reservoir to
18 the tubing string above the valve for producing gas from the reservoir and one or
19 more unloading ports connecting the annulus to the tubing string are blocked, to a
20 lift position, wherein the production ports are blocked and the unloading ports are
21 open for releasing high pressure gas stored in the annulus to the tubing string
22 above the valve to lift and remove accumulated liquids from the tubing string.

23

24

1 2. The system as described in claim 1 wherein the valve further
2 comprises:

3 - a tubular housing threaded for connection to the tubing string;
4 - a tubular valve body housed within a bore of the tubular
5 housing; and

6 - a valve stem, the stem housed within a bore of the valve body
7 and being axially movable therein between the first and second positions to
8 alternately open and block the production ports and block and open the unloading
9 ports respectively.

10

11 3. The system as described in claim 2 wherein the valve stem
12 further comprises:

13 - an uphole piston connected to an uphole portion of the valve
14 stem such that it blocks the unloading port when the valve stem is in the first uphole
15 position and alternately opens the unloading port when the valve stem is in the
16 second downhole position; and

17 - a downhole piston connected to a downhole end of the valve
18 stem such that it opens the lower production port when in the uphole position and
19 alternately blocks a bore of the tubular housing when in the downhole position.

20

21

1 4. The system as described in claim 3 wherein the valve further
2 comprises:

3 - an upper production port in communication with the tubing
4 string above the valve;

5 - a lower production port in communication with the reservoir
6 below the valve; and

7 - a tubular sleeve formed about the housing and sealingly
8 connected to the housing at an uphole end and a downhole end enclosing the upper
9 and lower ports to form an annular bypass chamber for fluidly connecting the upper
10 and lower production ports to bypass the valve.

11

12 5. The system as described in claim 2 wherein the means to
13 actuate the valve stem from the production position to the lift position is impact from
14 a plunger having fallen down the tubing string.

15

16 6. The system as described in claim 2 wherein the means to
17 actuate the valve stem from the lift position to the production position is a differential
18 pressure between the reservoir and the isolated annulus.

19

20 7. The system as described in claim 3 wherein the means to
21 actuate the valve stem from the production position to the lift position is impact from
22 a plunger having fallen down the tubing string.

23

1 8. The system as described in claim 3 wherein the means to
2 actuate the valve stem from the lift position to the production position is a differential
3 pressure between the reservoir and the isolated annulus.

4

5 9. The system as described in claim 3 further comprising a high
6 pressure gas poppet valve fitted between the valve body and the valve stem and in
7 fluid communication with the annulus, the poppet valve being operable to utilize
8 annulus pressure to assist in axial shifting of the valve stem.

9

10 10. The system as described in claim 5 wherein the valve further
11 comprises a plunger landing assembly to absorb excess downward force from the
12 impact of the plunger and to transfer sufficient downward force to the valve stem to
13 shift it to the downhole lift position.

14

15 11. The system as described in claim 5 further comprising:
16 - means for catching and retaining the plunger at a top of the
17 tubing string when the pressure in the annulus is below a predetermined threshold
18 sufficient to lift accumulated liquid to surface; and
19 - means for releasing the plunger to drop into the tubing string
20 when the pressure in the annulus reaches the predetermined threshold.

21

22 12. The system as described in claim 11 wherein the means to
23 catch and retain the plunger at the top of the tubing string is a spring loaded pin.

1 13. The method as described in claim 12 wherein the means to
2 drop the plunger is a pneumatic controller which acts to retract the spring loaded pin
3 to cause the plunger to fall down the tubing string.

4

5 14. A valve for enhancing the production of gas from a tubing string
6 extending down a wellbore to a reservoir having diminished pressure, the wellbore
7 having an isolated annulus charged with a continuous flow of high pressure gas and
8 a plunger lift system, the valve comprising:

9 - a tubular housing having a bore, the housing being connected
10 to the tubing string and having an upper production port fluidly connected to the
11 tubing string above the valve, a lower production port fluidly connected to the
12 reservoir below the valve and an unloading port fluidly connecting the isolated
13 annulus to the tubing string above the valve; and

14 - a valve stem having an uphole and a downhole piston, housed
15 within the valve housing and axially moveable therein between a first uphole
16 production position wherein the uphole piston blocks the unloading port, the upper
17 and lower production ports are fluidly connected and the downhole piston opens the
18 reservoir to the lower production port, and a second downhole lift position wherein
19 the downhole piston blocks the reservoir from the lower production port and the
20 uphole piston opens the unloading port.

21

1 15. The valve as described in claim 14 wherein the valve stem is
2 actuated to the lift position by impact from a plunger having fallen down the tubing
3 string.

4 16. The valve as described in claim 15 wherein the valve stem is
5 actuated to the production position by a differential pressure between the reservoir
6 and the annulus.

7

8 17. The valve as described in claim 16 further comprising a sleeve
9 sealingly positioned about the housing so as to form an annular bypass chamber for
10 fluidly connecting the upper and lower production ports.

11

12 18. The valve as described in claim 17 further comprising a valve
13 body housed within the bore of the tubular housing so as to support the valve stem,
14 the valve body having a port co-operating with the unloading port for fluidly
15 connecting the isolated annulus to the tubing string above the valve.

16

17 19. The valve as described in claim 18 further comprising a high
18 pressure poppet valve housed within a bore of the valve body so as to utilize
19 annulus pressure to assist in axial shifting of the valve stem.

20

21 20. The valve as described in claim 19 further comprising a plunger
22 landing assembly for the valve stem so as to absorb excess downward force from

1 the plunger and transfer sufficient downward force to the valve stem to shift it to the
2 downhole lift position.

3

4 21. The valve as described in claim 20 wherein the valve body
5 further comprises a latching mechanism to secure the valve body into the valve
6 housing.

7

8 22. The valve as described in claim 21 wherein the valve further
9 comprises a fish neck on the valve body and the valve stem so as to permit the
10 valve body and valve stem to be run in and retrieved by wireline.

11

12 23. A method of producing gas from a tubing string extending down
13 a wellbore into a reservoir having diminished pressure, the tubing string
14 accumulating liquid, the method comprising the steps of:

15 - providing a packer sealingly engaged in the wellbore for
16 forming an annulus between an exterior of the tubing string and an interior of a
17 casing string above the packer, the annulus being isolated from the reservoir, and a
18 valve located in a bore of the tubing string adjacent the packer;

19 - pressurizing the annulus;

20 - opening one or more production ports for fluidly connecting the
21 reservoir to the tubing string above the valve while blocking one or more unloading
22 ports connecting the annulus to the tubing to flow reservoir gas; and

1 - blocking the production ports and opening the unloading ports
2 to lift accumulated liquids out of the tubing string.

3

4 24. The method as described in claim 23 wherein the valve is
5 shuttled between a production position wherein the production ports are open and
6 the unloading ports are blocked and a lift position wherein the production ports are
7 blocked and the unloading ports are open.

8

9 25. The method as described in claim 23 wherein the blocking of
10 the production ports further comprises the step of:

11 - dropping a plunger down the tubing string so as to actuate the
12 valve as a result of impact from an uphole production position wherein the
13 production ports are open and the unloading ports are blocked to a downhole lift
14 position wherein the production ports are blocked and the unloading ports are open.

15

16 26. The method as described in claim 23 further comprising the
17 step of:

18 - compressing gas and introducing it into the annulus so as to
19 pressurize the annulus.

20

21 27. The method as described in claim 25 further comprising the
22 steps of:

- 1 - catching and retaining the plunger at a top of the tubing string
- 2 when the pressure in the annulus is below a predetermined threshold sufficient to lift
- 3 accumulated liquid to surface; and
- 4 - releasing the plunger to drop into the tubing string when the
- 5 pressure in the annulus reaches the predetermined threshold.
- 6